SCIENCE

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SUN-SPOTS AND PREDICTIONS.

ATTEMPTS are continually being made to connect terrestrial weather and storms with the motions and positions of the moon, the planets, and the sun. It has been fairly well shown that at the time of full moon there is a tendency, in some parts of the world, toward a diminution of clouds. One computation has shown a slightly greater rainfall during new moon on the Atlantic coast, but precisely the contrary on the Pacific coast. There has also been a very slight evidence of the increase of thunder-storms at the new moon. The influence of the planets must be absolutely inappreciable. When we consider the sun, however, we see at once the intimate connection between his radiant energy and all activities upon the earth. The growth and well-being of every living thing are absolutely dependent upon the sun's light and heat. It is believed by many that the sun's heat is the only agent to be considered in seeking for an explanation of our storms and all our weather changes. It is undoubtedly true that some form of solar energy is concerned in our storms, but it would be quite hazardous to say that electric influences from the sun are not far more potent for producing storms than even its heat. As the sun's heat is the most prominent energy recognized by our senses, every attempt has been put forth to determine whether this is constant as regards our climate, or whether there are fluctuations at long intervals. It is plain that these changes, if they exist, cannot be appreciable to our thermometers for centuries. The difficulty of measuring the intensity of solar rays by direct observation has been practically insuperable; and we may say that the total amount of heat which we receive is so great, as compared with its fluctuation from the greatest to the least, that we cannot hope for any definite solution of that question for years to come.

Coincidences.

In seeking any relation between the sun's light, heat, rotation, or appearances, and terrestrial phenomena, it is unsafe to trust to mere coincidences; but some connection of cause and effect should be established. For example: on Aug. 3, 1872, while Professor C. A. Young was examining the solar prominences with a telescope, he saw a most violent outburst upon the sun, and noted the exact instant when it occurred. Afterwards he found that his assistant at that very moment had observed a violent agitation of his magnetic needle; and an examination of the records at Kew, England, revealed exactly the same disturbance of the needle there. This may safely be regarded as more than a mere coincidence, and proves, in connection with other observations of a like nature, the intimate relation between solar disturbance and terrestrial magnetism.

It is well known that the sun is periodically spotted; that is, once in about eleven years spots gradually appear, and increase near the sun's equator. A remarkable fact about these spots is that their motion very near the sun's equator appears to be faster than in higher latitudes They revolve or come in sight in a little over twenty-five days in the former position, and in about twenty-seven days in the latter. This single fact should lead a great many of those who believe that our tornadoes are produced just as the spots appear by rotation, or about twenty-six days apart, to doubt the sufficiency of the explanation, because any such periodicity would be entirely broken up from the variable rotation period of the spots. The cause of these spots has not been well established, but it is probable that they are the result of increased electric activity on the sun. The attempt to connect this eleven-year period with our weather has proved intensely fascinating, and volumes of researches have been published. Such comparisons have proved, in the main, very illusory. While an apparent connection would be found in a few periods, yet, as the number of observations increased, the supposed connection was disproved. A single illustration will suffice. The attempt has been made repeatedly to connect the sun-spot period with fluctuations in temperature. In the nature of the case, it is impossible, perhaps, to prove whether the spots show the sun to be hotter or cooler during their existence. The fluctuations of temperature on the earth certainly do not show a preponderance either way, when compared with the appearance of sun-spots. This does not necessarily prove, however, that the spots do not influence our temperature, or that they do not show increased heat in the sun; for this increased heat would tend to produce clouds from a greater evaporation, and these in turn would prevent the sun's rays reaching the earth, and this would result in a cooling rather than a heating, which would mask the spot influence (see *Monthly Weather Review*, January, 1888).

Auroras.

Research has shown conclusively that our auroras and magnetic storms have an eleven-year period, and this is coincident with spot fluctuations; that is, as activity in spots increases, our auroras increase, and *vice versa*. It has also been definitely settled that the aurora is an electric phenomenon, and is intimately connected with magnetic storms on the earth. Here we have practically a number of coincidences which may be said to prove a definite connection between these phenomena without a positive knowledge that

they are both produced by a common force, or that the spots produce the effect upon the earth. The coincidences here, however, are very marked, and there are practically no discordances. These points should be most carefully borne in mind in all our studies in this line.

Sun-Spots and Storms.

Meldrum of Mauritius was one of the first to study the relation between cyclones and sun-spots, and found that during the three maximum periods of the spots between 1848 and 1871 there were nearly twice as many cyclones as during the minimum periods. The evidence in 1871, however, was far less than in 1848, and the more recent spot maximum of 1884 showed no increase in cyclones; so that this proof, which has been *the* one that has been relied upon above all others, has gradually dwindled down to practically nothing. It should be noted, however, that we have no absolute proof one way or the other; for during the spot maxima of 1871 and 1884 there may have been other forces acting which tended to diminish the activity of cyclones, or to divert them from the track of ships whose records Meldrum examined. Poey examined the West India cyclones, going back to 1750, and he thought that there were more cyclones during spot maxima. This record is so long that I have deemed it worth while to give it a careful study. The spot curve is remarkably well defined, with very few irregularities. The maximum and minimum points are very easy to find, and one can have no doubt as to the exact year of each period. The cyclone curve, on the other hand, is exceedingly irregular, and fluctuates back and forth across the spot curve. Comparing the cyclone and spot curves, I find that in the twenty-four maximum and minimum periods there are eight coincidences, ten positive discordances, and six doubtful cases (that is, cases which showed a flat curve for cyclones at the time of either maximum or minimum spots). This is a very poor showing, and certainly proves no intimate relation. No one can compare these curves and consider that the relation is proved by them.

If it could be shown that our cyclones were due to special heat or electric action, and that sun-spots tended in the same direction, there might be some hope in establishing a relation between them. Under the circumstances, however, it is necessary either to obtain accordance or else to explain away the discordances. Coincidences for a few periods are very probable, and prove nothing. The weakness of this cyclone research lies in the fact that only very limited portions of the earth have been considered. The only proper way would be to determine the extent of storm activity over the whole globe each day of the year, and then to compare this with sun-spot action. The reasons that many sun-spotists have met with so much encouragement in their researches have been two: 1. A "coaxing," as Professor Young puts it, of the critical point of a sun-spot period (that is, if the cyclone maximum came two or three years earlier or later than the spot maximum, it has been regarded as a coincidence); 2. A consideration of all manner of terrestrial disturbances as fulfilling the prediction or establishing the coincidence. All manner of tornadoes, storms, blizzards, hot waves, cold waves, floods, frosts, earthquakes, etc., have been drawn into their nets. It would seem that this practice should be regarded as very unreliable. If a spot produces a cold wave one week or at one time, it can never produce a hot wave at any other time. The determination of such a relation, if there be one, is one of the simplest mathematical processes that can be imagined, after the data are at hand, and yet the sun-spotists are very anxious to make their own computations. One of them writes, "I am very much afraid you will coax the data to disprove my view." It is very plain that no accurate research of this kind can ever be made by any one that cannot be repeated by any other person, and the fear of sun-spotists to have the verification of their theories taken out of their hands is well grounded.

Tornadoes and Sun-Spots.

If we take such a very great territory as that of the United States, and have stations at every sixty or a hundred miles, then count the number of stations each day at which the wind velocity reached twenty miles or more per hour, we would have a partial view of the average storm activity each day of the year. Again: if we could get a record of every violent storm in this region, and give it a proper weight, we would have a fair idea of storm activity, and could compare it directly with the known and easily measured spot activity. This has been done with the 2,221 tornadoes that have visited this country. The following table shows the relative intensity of tornadoes by weight, and the relative sun-spot intensity:—

Year.	Tornadoes.	Sun-Spots.	Year.	Tornadoes.	Sun-Spots.
1873.....	8	701	1881.....	169	730
1874.....	15	601	1882.....	286	1002
1875.....	69	272	1883.....	589	1155
1876.....	68	122	1884.....	461	1079
1877	111	92	1885.....	374	811
1878.....	108	24	1886.....	243	527
1879.....	92	49	1887.....	183	[300]
1880.....	269	416	1888.....	259	[100]

In this table, numbers in the sun-spot column are taken from the Greenwich photographs, and show the relative area covered by spots in millionths of the sun's surface. The earlier tornado records are in some doubt, as they are quite meagre. The enormous increase in both tornadoes and sun-spots during 1883 and 1884 is very striking, and seems to be a fact, though it will require several more eleven-year periods to establish the coincidence. There was an increased activity in collecting tornado data in 1882, but this continued through till 1887; so that the great increase in the two years above cannot be ascribed to this cause. Moreover, the list of 2,221 tornadoes was made up chiefly from the same source throughout all the years. There is a quite strong proof that the sun-spots are due to the action of electricity. Now, it has been shown that our tornadoes have an abundance of electric action, so that there is no inherent improbability in the supposition of a relation between these phenomena, aside from a mere coincidence in their phases.

Specific Influence of Spots.

If such a relation exists, some have thought that there ought to be a synchronism between the appearance of spots and resulting storms. The view has been strenuously sup-

ported, that within two or three days after the appearance of a spot on the eastern limb of the sun, or by the rotation of the sun, storms break forth or greatly increase in violence on the earth, and that it would be possible to use this fact in making predictions of violent storms. It will be easily seen that this view, if true, is of the extremest importance. No attempt is made to explain why it is that after two or three days this spot influence dies down, while the spots are still in full view of the earth for ten days. Since electric energy is transmitted at once from the sun, why should it not begin its action at once upon the earth? We must remember that this action is not a direct one, but electricity must act first upon the clouds or atmosphere, and possibly these upon the earth in turn, before the storm is produced or influenced; so that there need not be a direct connection between the two. The reason that this hypothesis has gained in favor has been already explained, and lies in ignoring discordances and emphasizing coincidences. Our curve of tornado activity furnishes a most extraordinary means of determining this specific effect of spots, if there be such.

The Greenwich, India, and Mauritius photographs of spots show exactly the appearance of each spot by solar rotation, and its area, or, as we may say, its relative intensity. We can easily determine, then, the activity of spots on the eastern limb of the sun during any day. It will be seen that this process is very dissimilar to the one adopted in obtaining the annual intensity; for that used the spotted area over the whole sun each day, while this method uses the area of a spot for three days only, and immediately after its first appearance by rotation. The years 1874 to 1886 were used, and the tornado months March to September. Curves were constructed showing both the spot and tornado activity for each day of the above period. An examination of the curves showed, (1) 46 tornadoes coincident with spots, (2) 156 spots without tornadoes, and (3) 393 tornadoes without spots: 46:593, or 8 per cent, which is insignificant. Next there were compared three successive days of spots, and the same days of tornadoes, during the extremely abundant tornado years 1882 to 1885 and the months April to August. It will be seen that in this comparison every thing was in favor of the tornado and spot-rotation hypothesis. There were 43 coincidences, 30 spot groups without tornadoes, and 79 tornado groups without spots: 43:109, or twenty-eight per cent. It is plain that this hypothesis breaks down completely under this investigation.

General Influence of Spots.

On observing the sun-spots carefully, we find that there are marked periods during which the spot activity increases and diminishes. In order to compare such periods with tornado activity, curves of both were drawn; and it was found that while a rise in the tornado curve occurred during the greatest activity of spots, yet the converse of this proposition was not true, for there might be a rise in the spot curve without a response from the tornado curve. This may have been due, as has already been suggested, by the masking of the spot effect at the earth's surface. The evidence, while showing a tendency to increased tornado action during an abundance of spots in at least one eleven-year period, does not show any marked specific action or relation between any definite spot phenomenon and a corresponding response by storms on the earth. The subject is exceedingly complex, and merits further study, especially in the line of a removal of any outside influences which would tend to mask the influence of spots at the earth.

Predictions.

It has been said that one of the best tests of the advancement of a science is its power to make predictions. Unfortunately, weather science has easily lent itself to all classes of wise or simple persons, and has suffered by their ignorant attempts at foisting upon it crude and imperfect forecasts of the future weather. An interest attends some of these efforts, however, from their curious and incongruous medley. Witness, for example, the famous lines of Dr. Jenner, beginning

> "The ass begins to bray,
> We shall have rain to-day,"

now so universally quoted. Many of these signs have a real significance: for example, the very old saying, "When it is evening, ye say, 'It will be fair weather, for the heaven is red;' and in the morning, 'It will be foul weather to-day, for the heaven is red and lowering.' " It has been suggested already that much may be learned from cloud appearances to assist in determining the probability of a tornado. A peculiar livid and greenish color is often seen, or ragged and angry-looking clouds in the west announce the greater disturbance. The appearance of lightning and heavy thunder usually precedes the tornado, though of course both these may be followed by an ordinary thunder-storm. The loud indescribable roar is unmistakable as a precursor of the funnel-cloud.

The question is often asked, however, "Can there be a prediction of a tornado a day, week, year, or even a century, in advance?" This problem has been most exhaustively studied by so-called weather prophets, and the public have been not a little mystified by the varying claims put forth by each prophet, and especially by the extraordinary success in such predictions that these men insist they have had. The scope of this paper will not permit more than an outline of these theories; but we may lay down certain rules that should guide us in estimating the value of such predictions, and in putting our faith in them. The moon, the planets, and the sun have been the most potent factors in these theories of storm-formation.

The Moon's Influence.

The comparative nearness of this body, and the fact that its phases occur in about seven days, which is approximately the interval for the occurrence of storms, have made it one of the most popular influences for weather changes. Soon after the death of the elder Herschel there appeared a singular set of weather tables ascribed to him, and purporting to give weather predictions according to the age of the moon. These tables have been scattered broadcast over this country. It is needless to remark that Herschel had nothing to do with them, as has been shown by his son. The moon is an inert mass, and can have no influence on our weather, except, as we have just seen, it has a very slight tendency to drive away clouds. Observations have shown that the tide produced by the moon in our atmosphere is only four-thousandths of an inch of mercury.

Planetary Hypotheses.

If the moon, only 250,000 miles away, has no marked influence on our weather, what must we think of the effect of the planets, millions of miles away? It is no wonder that at least one of these prophets, after giving the whole subject careful study, was forced to abandon the planetary hypothesis for the lunar theory. There is nothing which shows the utter absurdity of these planetary theories more forcibly than the introduction of the hypothetical planet Vulcan. This is needed in order to have a body revolving around the sun frequently enough to make his position relative to the earth coincident with our numerous storms. One of these prophets, an American, thought he saw Vulcan passing across the sun, and published a careful computation indicating, that, according to Le Verrier's orbit, the planet should have been exactly at that point; but, unfortunately for this hypothesis, it was shown by Professor Proctor, that, owing to a slight inaccuracy, this computation was wrong, and that this prophet, if he saw Vulcan at all, must have seen it directly *through the sun*, on the opposite side from the earth. Granting that there is a planet only 8,000,000 miles from the sun, and about 85,000,000 from us, is it not perfectly plain that its influence on terrestrial weather would be most completely overshadowed by the all-powerful sun behind it?

It is not a little remarkable that these prophets are entirely disagreed as to how this planetary effect is produced. One would have our storms and tornadoes coincident with the equinoxes of the planets, another with their oppositions and conjunctions; and so on. It is easy to see, that, under these circumstances, no two of these prophets agree on the dates of storms, but they are distributed quite uniformly for about half the days in the year. How does it happen, that, though these dates disagree, all these prophets are perfectly satisfied as to the exact fulfilment of their predictions? This is very simple to explain; for the man who predicts a storm on the 1st of the month, for example, verifies by a storm, say, in Illinois, while the one who has put his storm on the 3d of the month verifies by the same storm, which has now moved to Maine. There is just one crucial test by which we may satisfy ourselves of the worthlessness of these theories. It has been outlined in the last chapter. Let these prophets make a careful study of all the influences they can muster, and put down, no matter whether for the past or the future, the dates when they would expect the worst storms, and also the dates of fewest disturbances, then take the whole extent of this country, and establish the dates of most and least atmospheric disturbance. A comparison of these dates would quickly prove the value of such predictions. It is needless to add, that frequent and continued attempts to obtain these dates from at least four of these prophets, and to get any one of them to agree to this comparison, have lamentably failed.

There are not a few people who put great faith in such predictions, though a moment's thought would show how preposterous the claim is. For example: the Louisville tornado, on March 27 of the present year, was heralded as a perfect verification of a prediction for storms from March 28 to 30, and pains were taken to spread this fact from Maine to California. Suppose some one in the tornado district had read this prediction on March 27, and put faith in it: would he not have been misled? Again: if some one in Maine had read the prediction, would a storm in Kentucky apply to his locality? It is so easy to make a storm prediction, and so easy to verify it if one is allowed his own way, that there is no immediate prospect of silencing these prophets; but it is to be hoped that our citizens will study this matter for themselves, and before long obtain right views. It is plain that such a prediction made years beforehand can have no influence on right-thinking persons, for we know that it is impossible to predict the weather with certainty for even twenty-four hours.

Since 1872 it has been known that tornadoes and severe storms occur in the south-east quadrant of a depression system as it traverses the country, and in the history of the Signal Service frequent predictions of such storms have been made. A great deal of discussion has arisen as to the possibility of extending this system, and of giving ample warning of these outbursts. The most that can be said at present is, that the occurrence of such a storm is exceedingly rare; and in a very small space, while we may be able to indicate a region of several thousand square miles where such local outbursts may be expected, yet little more than this can be hoped for. People living in such districts, when they hear of the prediction, should not be disturbed, but simply take it as a probable occurrence at possibly one or two places, and in any particular locality should be guided by the appearance of clouds and other threatening signs which have become familiar. In fact, the question frequently arises as to whether it would not be better to omit such a prediction entirely; but if the right view be taken of it, that it is a warning to look out, and not a positive statement, no one should be unduly disturbed.

There are times when there seems to be an unusual amount of electricity present in the atmosphere, and when these severe storms occur without presenting any indication whatever on our maps or in our reports. It is impossible, from our present telegrams and knowledge of these storms, to make any predictions in such cases, though we may hope that in the future we may have a clearer idea of disturbed conditions at one or two thousand feet above the earth, which will enable better predictions. Such storms are not very severe as a general thing. A storm region like that in Kentucky on March 27, 1890, is plainly indicated on our maps, and predictions of severe local storms were sent all through that region nearly twelve hours in advance.

There has been a gradual development in these predictions as the conditions have become more familiar. One of the later attempts was made in 1884, and in this case the whole country east of the 102d meridian was divided into eighteen districts, and private predictions were made each day during the tornado season as to whether or not a tornado would occur in any district. The claim was made that in this case 97 per cent of the predictions were successful, but a serious fallacy in these attempts was soon pointed out. To say that on any day in New England, for example, there would be no tornado, was no prediction at all; for only under most extraordinary conditions, occurring once in three or four years, are any tornadoes experienced there. Several verifications of these predictions according to mathematical principles gave from 13 to 20 per cent of success. This does not indicate, however, the measure of skill that has been at-

tained in tornado prediction, but was due primarily to an injudicious system of predicting, and secondarily to an improper estimate of the nature of the problem. It would be impossible, of course, to say that such a tornado as that at Grinnell in 1882, and the recent one at Louisville, would occur in any district. All that we can do is to predict a disturbed region. In verification, it would hardly be fair to adopt principles which could be used in determining the skill of a marksman shooting at a target, for example; but we must take into account the knowledge we have already gained of the relative violence and the manner of occurrence of such storms. We must determine, on a scale, the number of violent storms occurring in any district where such storms were predicted, and not confine attention to the most violent alone. To draw an imaginary line, and say that if a storm occurs within five miles of that line, in a district where it was predicted, it shall count fully as a success, but if it occurs five miles on the other side of that line it shall count as a total failure, is to impose restrictions upon the problem which seem entirely unreasonable.

In a study of tornado predictions made by Mr. Finley for June, 1885, the present writer assumed "that violent storms occurring, in any district predicted for, half way between the centre and edge, shall have weight 1; in the rest of the district, $\frac{3}{4}$; to the centre of the next outlying district, $\frac{1}{2}$; to the edge of that district, $\frac{1}{4}$; all outside of these, 0" (see *American Journal of Science*, August, 1887, p. 129). The percentage of skill attained as thus measured was 49. Mr. Curtis, taking the same predictions and discussing them mathematically, found 14 per cent. Mr. Curtis has more recently (1887) adopted somewhat the method suggested above, and obtained 40 per cent. These percentages, however, mean very little as to showing a real knowledge of the probable occurrence of tornadoes, for it is necessary to radically change the system of predicting. It would seem wiser to determine as nearly as possible the central point of any probable disturbance, three hundred or four hundred miles to the south-east of a general storm, and then give boundaries more or less definite to the violence of the storms. This we are able to do from what is known of the behavior of such storms. In verifying, we should consider all the storms that occurred, and give weights corresponding to their distance from the centre of the disturbed region, and to their intensity.

Tornado Photographs.

One of the most recent developments in tornado studies has been a strong desire to photograph this extraordinary appearance. It is very unfortunate that this desire has become so strong that unscrupulous persons have resorted to photographing sketches of tornadoes, and selling them for the real article. It is also unfortunate that all these alleged photographs have been made at distances of from ten to twenty miles. It is a great desideratum that we have many photographs taken at much closer quarters, and this is not so impossible as might at first sight appear. It would be useless for any one to attempt a photograph on the south side of a tornado within a thousand or fifteen hundred feet; but on the north side we have repeated authentic observations of persons who stood within one hundred and fifty feet, and did not feel any violent wind. It is much to be hoped that a photographer will catch, by his instantaneous flash, one of these monsters as it passes just south of his position. It will require more than the usual amount of bravery to do this, however, as is very plain.

Alleged Photograph.

While nearly all these photographs show quite plainly their origin, yet there is a single exception in a picture representing an alleged tornado near Jamestown, Dak., on June 6, 1887, recently published in a prominent magazine. There is no doubt that this is a genuine photograph. There exist most serious difficulties in regarding it a tornado-cloud, however. The picture shows a dense mass of cloud extending from the trees at the earth up to the uniform veil of cloud above, with clear sky on either side. This mass has a thickening on the right-hand side, and this is supposed to be the tornado. The appearance is exactly that of a cloud-burst, as has been often witnessed, and not at all of a tornado. The dimensions of the camera and the distance of the cloud give the height between two and three miles. The distance of the cloud was variously estimated from eighteen to twenty miles. There was no destruction, and no one saw it, at the spot where the tornado was supposed to be. The only way it could be located was by following two lines of sight of persons from ten to fifteen miles away until they crossed. Drawings of a sand-whirl, not far from the alleged tornado, showed a funnel-cloud, and nothing at all like this indefinite mass in the picture. The evidence is quite conclusive that on this day there were in this region several appearances simulating cloud-bursts, tornadoes, and sand-whirls. It is very probable that this photograph was that of a cloud-burst within two or three miles of Jamestown. It is highly improbable that either a cloud-burst or a tornado ever had a height exceeding two or three thousand feet. A photograph of a funnel-cloud showing details, and especially two or three photographs taken as the cloud comes up and passes by, would be of the highest interest, and invaluable at this stage of our studies.

H. A. HAZEN.

NOTES AND NEWS.

THE Norwegian Storthing, by 73 votes against 39, has voted a grant of 200,000 kroner for Dr. Nansen's north pole expedition, says *Nature*.

—The third international shorthand congress will be held at Munich from Aug. 7 to 17, says *Nature*. The centenary of F. X. Gabelsberger, the originator of modern German shorthand, will be celebrated by those who attend the meetings, and a bronze statue of him will be unveiled.

—The Entomological Club of the American Association will meet at 9 A.M., on Wednesday, Aug. 20, in the room of Section F, State House, where members of the club will register and obtain the club badge. The president is Professor A. J. Cook, Agricultural College, Mich.; secretary, F. M. Webster, Lafayette, Ind. Members of the club intending to contribute papers will send titles to the secretary. The Botanical Club will hold a meeting, as usual, on Thursday, Aug. 21, at the State House. Communications should be sent to the president, Dr. N. L. Britton, Columbia College, New York, or to the secretary, Dr. Charles R. Barnes, University of Wisconsin, Madison, Wis. The Society for the Promotion of Agricultural Science will hold its eleventh annual meeting in Indianapolis, beginning on Monday evening, Aug. 18, in the room assigned to Section I in the State House, and continuing on Tuesday. For further information address Professor W. R. Lazenby, secretary, Ohio State University, Columbus, O. The

American Geological Society will hold its semi-annual meeting at the State House in Indianapolis on Aug. 19. Professor J. D. Dana, New Haven, Conn., is the president, and Professor J. J. Stevenson, University of the City of New York, secretary. Members of the association arriving in Indianapolis before the meeting should call for information at the temporary office of the local secretary, No. 19½ North Pennsylvania Street. A few days before the meeting a local office of information will be established near the railroad-station, as will be stated in the circular of the local committee.

— Professor Arthur Winslow, State geologist of Missouri, in submitting to Gov. Francis a statement setting forth the operations of the State Geological Survey during the month of June, says that during the early portion of the month the results of detailed field-work in the coal-fields were reduced, and transferred to the final map. Since this time field-work has been continued, and about twenty square miles have been covered. Paleontologic work has been continued in Pettis County, and has been extended into Lafayette County as far as Odessa. Several hundred pounds of specimens have been collected, and have been shipped to Professor Williams for study. On June 20 Mr. Erasmus Haworth reported for work, and has been assigned to the south-eastern part of the State, where he is engaged in defining the distribution and relations of the crystalline rocks of that section. Mr. Haworth is professor of geology and mineralogy at Penn College, Oskaloosa, Io. He has worked in the south-eastern portion of the State in past years, and has volunteered his services to the survey during the present summer. In the laboratory the analytical work on the mineral waters collected in April is completed, as well as the calculation of results, and the preparatory notes for a report on the results have been written out. In addition, analyses have been made of forty-seven specimens of limestone from quarries in and about St. Louis, with the object, among others, of determining their qualities for building-purposes, and for the production of lime and cement. Inspections have been made in Cape Girardeau and Stoddard Counties. In Cape Girardeau County clay deposits of promising appearance were visited. The qualities of the clay and the distribution of the deposits deserve determination. In Stoddard County a deposit of brown coal or lignite was visited, near Ardecla, on the Cotton Belt Railway. This coal has been opened up during the past winter by shafts and drifts. It occurs associated with the clays and sands of Crowley's Ridge. Similar coal is found along the same ridge farther south, in Arkansas.

—The latest plan for connecting a moving tram-car to an underground conductor without a slot in the roadway is that of the Lineff Electric Traction and Lighting Syndicate, of 11 Queen Victoria Street, London. According to *Engineering*, the track consists of the usual grooved rails, and a third or contact rail between the others. This is flat-topped, and the surface lies flush with the roadway. It is formed in short lengths, about three feet, separated from each other by about half an inch of asphalt. These short rails are electrically insulated from each other, and the current is directed into each of them in succession as the car passes over them. This, as is well understood, is to prevent the excessive leakage that would take place if a long length of rail were in connection with a wet roadway, and also to prevent other vehicles making a short circuit between the contact rail and the return-current rail. The connection of the short rails with the copper conductor is made by a magnet on the car acting on a contact-maker under the rail, one end of this contact-maker being joined to the conductor. On the under side of the car is a very powerful electro-magnet about one and a half times the length of a rail. At each end it has a pole-piece, consisting of a roller running on the rail, and two blocks just clearing the rail. This magnet is energized by the main current, and consumes one hundred and twenty to one hundred and fifty watts, although sixty are said to be sufficient for the purpose, under favorable circumstances. The rail, which is five or six inches deep, stands on a longitudinal earthenware sleeper; and the whole is solidly embedded in a mass of asphalt, which extends below the sleeper. In a groove in the sleeper runs the conductor, and in a second groove is laid a strip of galvanized hoop iron. This strip is connected at one end to the conductor, and the other end is free. When the magnet passes over it, the rail attracts the iron, which rises, and makes contact with it. The current then flows from the conductor through the strip to the rail, and thence by a bush to the motor on the car. Neither the strip nor the rail has any special contact surfaces. They are both galvanized, and there is no other means provided to insure good connection. As soon as the magnet has passed, the rail ceases to be magnetic, the strip falls back, and that particular rail is again insulated, its office being taken by the one in front of it; and so on. The principal feature of novelty lies in the use of a second, or so-called "hidden rail," placed alongside the contact rail underground, and, like it, embedded in the asphalt. This is also in short lengths, but it is disposed so as to break joint with the first rail, and thus reduce the resistance of the magnetic circuit. It is stated that by the use of this second rail a very much less powerful magnet is able to move the contacts. The inventor seems to have aimed at cheapness of construction; and it is feared that difficulties will arise in practice from the crudeness of some of his arrangements, although a short experimental line in the yard of the West Metropolitan Tramway Company, Chiswick High-Road, works very well.

—Miss C. W. Bruce offers the sum of six thousand dollars during the present year in aiding astronomical research. No restriction will be made likely to limit the usefulness of this gift. In the hope of making it of the greatest benefit to science, the entire sum will be divided, and in general the amount devoted to a single object will not exceed five hundred dollars. Precedence will be given to institutions and individuals whose work is already known through their publications, also to those cases which cannot otherwise be provided for, or where additional sums can be secured if a part of the cost is furnished. Applications are invited from astronomers of all countries, and should be made to Professor Edward C. Pickering, Harvard College Observatory, Cambridge, Mass., before Oct. 1, 1890, giving complete information regarding the desired objects. Applications not acted on favorably will be regarded as confidential. The unrestricted character of this gift should insure many important results to science, if judiciously expended. In that case it is hoped that others will be encouraged to follow this example, and that eventually it may lead to securing the needed means for any astronomer who could so use it as to make a real advance in astronomical science.

—The increasing importation of foreign meat to England has resulted in the invention of a number of refrigerating appliances, among them Hill's patent system of dry-air refrigerating apparatus, which is on view at the working dairy at the Royal Military Exhibition, Chelsea, Eng., and at the offices of the company, 114 Cannon Street, London. The distinctive feature is that no machinery is in use, the cold air being produced from the distillation of ammonia gas, a principle which is not by any means new. The apparatus consists of steam-generator, ammonia boiler, separator, and condenser for producing cold, and a refrigerator or cold chamber. This chamber, as described in *Engineering*, is constructed in most cases of a double casing of wood, lined with charcoal as a non-conductor; and the roof is formed by a tank containing a bath of chloride of calcium liquor in sufficient quantity to store up the cold as produced. In the case of the apparatus exhibited on Cannon Street on Wednesday, June 25, the chamber was seven feet by nine feet by seven feet high, and the ammonia boiler two feet diameter by ten feet long. The solution of ammonia in the boiler is heated by steam from any boiler, or from a specially constructed slow-combustion stove, with a spiral coil giving large heating surface. Alongside it is placed a water separator for drying the steam, which passes to a boiler three-fourths filled with a solution of ammonia. To this the steam entering by several pipes imparts heat, driving the ammonia into the form of gas. Above the boiler is placed a separator for taking off water carried forward in the distillation of the ammoniacal gas. The water thus separated passes by gravitation to the boiler. Alongside it is a corresponding cylindrical vessel into which the dried ammoniacal gas passes, and there it is condensed by its own accumulation of pressure, and the latent heat carried off by the

circulation of cooling water. This liquid anhydrous ammonia flows into the refrigerators suspended in the tank forming the roof of the cooling-chamber. The pressure is then rapidly reduced by opening a communication with a separate chamber, and the sudden evaporation of the liquid anhydrous ammonia takes place at the expense of the sensible heat in the cold-storage bath in the tank, which therefore becomes very cold, and draws heat from the chamber in which the meat is stored. The bottom of the tank is corrugated, which gives a large increase in the cooling area; and to the lower angles of the corrugation, gutters are suspended, carrying off the water, so that the atmosphere is dried as well as cooled. On June 25, the temperature, after the doors of the chamber were closed, was reduced in a comparatively short time by about 40° to 39°. It was tested from the evening of June 14 to the morning of the 20th, and it is said that the temperature of the liquid in the tank rose in that time from 16½° to 31°; the fall of temperature in the chamber being from 52° to 36¼°, while in the office in which the chamber was placed the fall was from 65° to 61°.

—Among the papers read at the closing meeting of the Royal Society, London, was one by Professor Ewing of the Dundee College, entitled "Contributions to the Molecular Theory of Induced Magnetism," in which experiments of a novel and curious kind were described, leading to an important conclusion. Professor Ewing has examined experimentally Weber's theory of molecular magnets, according to which the molecules of iron are always magnets, which point anyhow in an unmagnetized piece, but are turned round to point one way when the iron is magnetized. It is well known that in the development of this theory by Maxwell and others there has been much difficulty in reconciling the results of the theory with what is known about the magnetic quality of iron and steel, and many arbitrary assumptions have been suggested in order to make the theory fit the facts. Professor Ewing's experiments have removed this difficulty, showing that no arbitrary assumptions are necessary, and that the known character of the magnetizing process may be deduced from the molecular theory in its simplest form. The experiments, as described in *Nature*, were made by means of a model in which a large number of small pivoted permanent magnets are grouped to represent the molecular structure of iron. When a magnetic field is applied, the action of the small magnets on one another makes them behave in a way that exactly agrees with the observed behavior of a bar of solid iron when it is magnetized. The model exhibits all the variations of susceptibility which are known to take place, and explains how magnetic hysteresis occurs without any thing like friction among the molecules.

—An exceptionally pretty and instructive series of new experiments upon the action of carbon heated to whiteness in the electric arc on various gaseous compounds is described in a late number of the *Berichte* by Professor Lepsius of Frankfurt, according to *Nature* of July 3. Perhaps the most important are a group of four experiments illustrating the relative combining powers of the four elements, iodine, sulphur, phosphorus, and carbon. The apparatus employed consists of a specially modified Hofmann eudiometer, one limb of which is 40 millimetres in diameter and 300 millimetres long, and the other longer limb narrower, and furnished with a mercury reservoir at its upper end. The wider limb, which is the re-action tube, is furnished with a stop-cock at the top, and just below this are two tubuli through which the adjustable carbon poles are inserted. At the base of the wider limb a second stop-cock is placed so as to permit of the adjustment of the mercury. The gas to be experimented upon is introduced into the apparatus at the upper stop-cock by allowing mercury to run out at the base. Four such eudiometers are arranged in a row, and 100 cubic centimetres of gas introduced into each. Into the first, hydriodic acid is introduced; into the second, sulphuretted hydrogen; into the third, phosphuretted hydrogen; and into the fourth, marsh-gas. The gases thus stand at the same level in each of the four re-action tubes. The current from a battery whose electro-motive force should amount to 60 to 80 volts is then allowed to pass between the carbon poles, which are, of course, in contact at first, and then gradually drawn away until the maximum arc is obtained. Each re-action may be performed separately, or all four may be allowed to proceed simultaneously by adopting an arrangement in multiple arc. In hydriodic acid the brilliant arc-light is tinted a magnificent purple, and the whole space above the mercury becomes filled with violet vapor of iodine. Notwithstanding the considerable heating effect of the discharge, the volume of gas perceptibly diminishes, the liberated iodine rapidly depositing in minute crystals upon the walls of the tube. So rapid, indeed, is the diminution in volume, that mercury requires to be poured into the reservoir to prevent the entrance of air into the re-action tube. In a very few minutes the re-action is complete, and the mercury ceases to rise. In sulphuretted hydrogen the light is colored blue, and copious clouds of suphur are produced, which settle upon the walls in the form of a white transparent coating. The volume of gas is considerably augmented, owing to the expansion by heat, and the re-action is likewise completed in a very brief space of time. In phosphuretted hydrogen the arc glows with a dazzling red light, the volume visibly augments at a rapid rate, and red clouds of phosphorus are thrown off, the glass walls being covered with red phosphorus, among which are to be found notable quantities of the ordinary yellow variety. The mercury attains its maximum height in the narrow limb in a minute, at most, from the moment of switching on the current. In the case of marsh gas, the whiteness of the arc appears at first to be rendered more intense, and is surrounded by dense black clouds of carbon, which form a striking background. The upper part of the vessel, however, soon becomes covered with an opaque deposit which perceptibly diminishes the brilliancy of the light. The volume appears to increase by leaps and bounds, and in a few seconds attains its maximum. At the end of the experiment, after cooling, the volume of hydrogen left in the first case is 50 cubic centimetres; in the second, 100; in the third, 150; and in the fourth case, 200; thus showing in a most striking manner that an atom of iodine combines with one atom of hydrogen, sulphur with two, phosphorus with three, and carbon with four, atoms of hydrogen.

—According to *Nature* of July 3, the third summer meeting of university extension and other students will be held at Oxford in August next. The meeting will be divided into two parts. The first part of the meeting will begin with an inaugural address by Professor Max Müller at 8.30 P.M. on Friday, Aug. 1, and will end on Tuesday evening, Aug. 12. The second part of the meeting will begin on Wednesday morning, Aug. 13, and end on Tuesday evening, Sept. 2. This period will be devoted to quiet study. The courses of lectures will be longer than those delivered during the first part of the meeting, and will deal in greater detail with the subjects then introduced.

—The clove-tree was introduced into Zanzibar about the year 1830, and its cultivation now forms the chief industry of the islands of Zanzibar and Pemba. The chief supply of cloves is obtained from these islands. Consul Pratt, who has lately written a report on the clove-culture of Zanzibar, says that a ten-year-old plantation should produce an average of twenty pounds of cloves to a tree. Trees of twenty years frequently produce upwards of one hundred pounds each. Mr. Pratt reports that the yield of the present season will probably exceed that of any previous season, and amount to thirteen million pounds, averaging a local value of ten cents per pound.

—A pneumatic dynamite gun built for the British Government was tested at Cold Spring, N.Y., on July 8, in the presence of several military and naval officers. As the test was merely to determine the range and capabilities of the gun, and not the destructiveness of the projectiles, the latter were filled with sand instead of an explosive. Four shots were fired, two of which were failures, the thin brass shells of the projectiles bursting in mid-air, owing perhaps to defective packing of the sand. The other shots were successful; the projectiles, weighing 520 pounds each, attaining a range of 4,008 and 4,680 yards respectively, the contract only requiring a range of 3,500 yards. The gun, or shooting-engine as it may be called, is fifty feet long, and weighs much less than four tons. It is a modification of those with which the dynamite cruiser "Vesuvius" is armed.

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Attention is called to the "Wants" column. All are invited to use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

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NEWS FROM CLARK UNIVERSITY.

A ONE-YEAR'S course in the history and principles of education will begin in October next at Clark University, and continue till June, 1891. This course will be given by the president of the university, Dr. G. Stanley Hall, and by Dr. William H. Burnham, docent in education, and will be divided as follows: I. General history of educational ideas and institutions in antiquity. II. General history of educational ideas and institutions during the middle ages and down to the early decades of the present century. III. Contemporary educational institutions. A good part of the year will be spent in this field, which will be treated as follows: The educational system of Germany will first be considered, and each class of institution from the kindergarten to the university will be described, including legislation, administration, financial methods, supervision, buildings, curricula, training, testing and examination of teachers, methods of instruction in the leading subjects, educational literature, brief biographies, etc.; French educational institutions will then be described in the same way; and then will follow Italian, Scandinavian, Russian, British, and American educational institutions. While the presentation of the systems will necessarily be more or less historical, the chief object will be to describe these systems as they exist to-day. While considering elementary work and grades, much stress will be given to intermediate and higher education, including such topics as the constitution of universities, with historical sketches and descriptions of typical institutions, both European and American; the relations of government to science in the various countries; learned societies, associations, and academies; professional and technical instruction; examinations; etc. IV. Philosophical conclusions and practical applications of this survey; general views concerning the end, direction, and methods of education, with reference to the needs and problems of our own country.

In preparation for these courses, Dr. Burnham, a Harvard graduate, who gave his chief attention to philosophical courses, taught successfully in a normal school, and studied psychology and education three years in Baltimore, taking the degree of doctor of philosophy there in 1888, was some time since sent to Europe by Clark University, to study special problems and institutions in several European countries. Dr. Hall, who represented this department at the Johns Hopkins University, spent last year in visiting educational institutions and collecting literature and other material for this course in every country in Europe except Portugal. A carefully chosen collection of educational literature covering the topics of this course will be placed at the disposal of students, and their reading will be individually directed in it. The methods will consist of lectures, general and individual conferences, special lines of reading, etc. Certificates of attendance will be given to those who follow the entire course, and certificates of proficiency to those who desire to pass an examination at the end of the year. Should the attendance warrant it, and should it be desired, pedagogical excursions may be conducted to institutions in Worcester and other neighboring cities. In addition to these strictly educational courses, the philosophical and psychological courses may, by special arrangement, be attended by students of education. This course is intended for those who desire to qualify themselves for professors of education in colleges or normal schools, and for superintendents, principals, and others who desire to make a specialty of education. For further information address the clerk of the university, Worcester, Mass.

PRESENT CONDITION OF SILK-CULTURE IN FRANCE.

WITH reference to the recent demand of certain delegates representing the agricultural, and especially the silk-growing, industry of southern France for a protective duty upon imported cocoons and raw silks, with certain restrictions upon silk-manufacturers in respect to "loading" their goods in the process of dyeing, the United States consul at Marseilles gives a sketch of the history and present condition of this branch of French industry.

The cultivation of the mulberry-tree for the rearing of silk-worms began in the south of France early in the seventeenth century, but it was not until a hundred and fifty years later that the industry became important or largely profitable. By the year 1780 the annual product of cocoons had risen to 6,600,000 kilograms, which were then worth about 2s. a kilogram. This was a lucrative result in those frugal times; and the business continued to flourish until 1853, when the crop reached 26,000,000 kilograms at about 3s. 9d. the kilogram, thus adding a sum of about £4,700,000 to the wealth of the rural classes. The country was admirably adapted to the growth of the mulberry-leaf; the warm, dry climate of Provence and Comtat Venaissin was favorable for the worm; the labor of raising the cocoons and reeling them could be performed by women, aided to some extent by children and aged people, thus entailing scarcely any increase in the expenses of the farm; and the permanent prosperity of the industry seemed for a time assured.

Then a series of disasters began. The peasants, in their eagerness to raise every possible silk-worm, had for years overstocked their premises, and in the crowded, ill-ventilated, and often dirty and neglected *magnaneries* the worms degenerated from year to year until they became a prey to several new and destructive diseases. The most serious of these were the *muscadine*, which was thought to have been imported with silk-worm eggs from Turkey; and the *pebrine*, a malignant cryptogamous infection, generated by the conditions above cited, and which is commonly cited in France as *la maladie*. The *muscadine* caused a loss of £800,000 in a single season. In thousands of cases every silk-worm in a farmhouse or breeding-establishment perished; and this disease

was succeeded by the *pebrine*, which swept the silk-growing district irresistibly, until a discovery was made which provided a practical escape from its ravages. This discovery was a new and certain method of detecting the disease in the chrysalis, or moth, which lays the eggs that serve as the seed for next year's growth of silk-worms. By the time, however (1880–81), that this remedy was generally known and practised, the situation had become in other respects almost hopeless. After the war of 1871, wages and the cost of living had greatly increased. Selling prices for farm produce of all kinds, which had formerly been ample, were no longer sufficient, in many cases, to pay the cost of production. The price of cocoons, which at one time had been as high as eight francs a kilogram, fell to six, and then to four francs, and even less. Discouraged by disease and low prices, thousands of farmers rooted up their mulberry-trees for fire-wood, and devoted the ground to vines and other forms of culture. The skilled women, who had formerly gathered the leaves for the silk-worms, and reeled the cocoons, had gone to other employments at higher wages than the languishing silk-industry could afford to pay. By this time French manufacturers no longer depended upon home-grown silk.

During recent years important discoveries in the chemistry of silk-manufacture had enabled the spinners, by skilful dyeing and "loading" their goods with gums and mordants, to use inferior grades of Japanese, Chinese, and Italian fibre in place of the superior organzines which had given the fabrics of Lyons and the ribbons of St. Etienne their lustre and renown. It is urged that the manufacturers were protected by high import duties; but the raw material which fed their looms was, and still remains, duty free. It is said that the weighting and loading of French silks have been carried to an extent which has injured their reputation, and not only disgusted French consumers of such goods, but raised the question whether the use of so much low-grade Asiatic fibre has been, after all, a blessing to the manufacturers of France.

There is now a new and steady demand for better material, and the question has now arisen, "Why not protect the native silk-growers, and raise it at home?" It is argued that it is solely due to the competition of foreign cocoons, and the increasing use of low qualities of silk loaded with fraudulent dyes, that French silk culture has languished since Pasteur's discovery conquered the malady which had threatened its existence. The peasants of France, who hatched more than a million ounces of silk-worm eggs in 1872, used less than a quarter of that quantity in 1886.

In conclusion, Consul Mason says, "The government, which had increased the duties on wheat and cattle, left the agriculturists without protection, and, seeing no hope of relief, many have given up the strnggle, and either emigrated to South America, or flocked to the already overcrowded cities and towns. There are, in this consular district, six rural departments in which the population is steadily decreasing, and this decadence of agricultural prosperity involves a serious menace to France."

HEALTH MATTERS.

Oxygen-Gas in Pneumonia.

IN an article on the value of oxygen-gas in pneumonia, in the *Lancet*, May 24, 1890, Dr. John Chambers says that during the early months of last year, as a practising physician in the United States, he met with many cases of the disease, occurring chiefly in adults and men of middle age. These symptoms in the cases observed were due directly to the deficient aeration of the blood. They were marked by difficulty of breathing, together with weakness of the heart's action. The faulty aeration is recognized almost at its onset by the livid hue of the lips, of the ears, and the finger-nails. This condition is well known to every physician, and, as it is the token of immediate danger to the patient, it is important that the best measures be taken to overcome, if possible, the difficulty. In pneumonic cases in young and old, presenting symptoms of deficient blood aeration, the inhalation of oxygen-gas has, in Dr. Chambers's hands, proved to be a remedy of remarkable power. Under its use, the lips recover their redness, the breathing becomes easy, and the toneless heart is strengthened in its action.

As to the method of using the gas, a few words may be added. A supply of pure oxygen-gas can be easily obtained from the laboratory of a chemist. It is collected in a receiver, and can be conveyed a considerable distance without loss of gas. In the immediate use it is better to fill a rubber bag from the tank than to give the gas directly to the patient. The rubber bag should have a capacity of one or two gallons, and be provided with a stop-cock at one end. To this a short rubber tube ending in a mouth-piece can be readily attached. The mouth-piece is applied over the mouth of the patient, the valve of the bag is turned, and the whole or any portion of the gas in the bag can be inhaled at a single dose. As the gas is heavier than air, its escape from the bag will be facilitated by holding this above the level of the mouth, and slight pressure upon the bag will still further assist in the inhalation. From half a gallon to a gallon of gas can be given every half-hour with perfect safety, and with great relief to the sufferer's symptoms. Such doses have been continued for four days and nights, with the most satisfactory results. Life has certainly been saved in many cases when it has seemed that death was inevitable. When cardiac weakness is urgent, an excellent and safe tonic is found in sulphate of strychnia, which may be given in doses of one-eightieth of a grain every four or six hours, until a decided change in the condition of the pulse is manifest. When this occurs, the strychnia is omitted, but may be of use again in a day or two if the pulse should fail. The relief in desperate cases, where asphyxia is threatened, is so marked that it is astonishing physicians have not more generally used this simple remedy. The use of oxygen-gas imposes a great deal of labor on physicians and nurses. With a little training, however, the nurse soon learns to give the oxygen, thereby relieving the physician. Two nurses should be employed,—one for the day, and one for the night.

An Epidemic of Pulmonary Phthisis.

Dr. Marfan, chief of the medical clinic of the Faculty of Medicine of Paris, gives, in the *Semaine Médicale*, Oct. 23, 1889, the details of a localized epidemic. In an important business-house in the centre of Paris, twenty-two persons were employed about eight hours a day. One of them, aged forty, employed at this place for twenty-four years, had been phthisical for three years, when he died on the 6th of January, 1878. He coughed and spat upon the floor for three years, and did not leave his work till three months before his death. From that time, out of twenty-two persons employed, fifteen have died. One only died of cancer: the remaining fourteen died of pulmonary tuberculosis. One year before the death of the first person, who appears to have been the starting-point of the epidemic, two employees, who had been connected with the same business for more than ten years, began to cough and spit upon the floor. They died in 1885. Beginning with the end of 1884, the deaths followed each other at closer intervals.

Dr. Marfan states the unsanitary conditions of the apartment in which these persons were employed. It was small, and the cubic air-space was less than ten cubic metres (350 feet) to each person. It was badly ventilated, badly lighted, and the gas was burned a part of each day, especially in winter. The floor was of wood, uneven, cracked, and very dirty. The first victim of phthisis, and those who followed, spat directly on the ground; and the sputa, becoming dry, was converted in this already unhealthy apartment into a poisonous dust. The room was swept each morning; and sometimes the employees arrived before the sweeping was finished, and while the dust was still floating in the air. It was difficult to sweep the room thoroughly, since the tables were fixed to the floor. It appears very probable that the swallowing and inhaling of this tuberculous dust was an essential factor in the propagation of the disease.

The proprietors of the place where the deaths occurred removed and burned the floor, and so rapidly was the work accomplished that the reporter had no time to collect a sample of the dust from the cracks in the floor for the purpose of experiments upon animals. A new floor was laid, which was waxed and treated from

time to time with spirits of turpentine, all painted surfaces were repainted, and Dr. Marfan recommended that the floor should be swept in the evening after the departure of the employees, and that the windows should be left open all night.

Dr. Vallin recommends in place of these measures a mixture of equal parts of coal-tar and spirits of turpentine, or of paraffine dissolved in warm petroleum, and, in place of the sweeping, the removal of the dust by sponges, or cloths moistened with an antiseptic solution.

Tissue Metabolism in Cancer.

Dr. F. Müller has made some careful comparative observations upon the urine in cases of cancer and other wasting diseases, and in simple starvation. He finds, according to the London *Lancet*, that in the cancerous the excretion of nitrogen far exceeds the amount ingested, and infers that this excess must in consequence be derived from the disintegration of the albuminoids of the body. However, in two out of seven cases this loss was not greater than occurred in other individuals similarly insufficiently nourished. The chlorides were, on the other hand, notably diminished,—a fact, he thinks, pointing to the source of the excreted nitrogen; viz., from the organ albumen, and not from the circulating albumen. Obviously, however, many diseases share, with carcinoma, in this disintegrating process, as Müller showed to be the case in chronic febrile affections, especially severe forms of malaria, in leukæmia, and pernicious anæmia. Previous observers do not coincide in their statements on this head as regards leukæmia. Voit and Pettenkofer found no marked evidence of increased metabolism in this affection, and Fleischer and Penzoldt concurred in this so far as regards mild cases. But in severe cases the last-named find the urea to be increased both absolutely and relatively. Sticker and Klemperer arrived at the same conclusion. Respecting pernicious anæmia, there is a concurrence of testimony in support of increased nitrogenous excretion. Reverting to cancer, this evidence, Müller thinks, goes to prove that malignant disease excites the formation of metabolic products which are poisonous to the organism. He points out that cachexia develops in the cases of malignant growths, no matter how limited, and without their involving any important organ; whereas a non-malignant tumor may attain great dimensions without affecting the excretion of urea. At the same time no such poison or ferment destructive of albumen can be isolated from cancerous tumors, although the fact pointed out by Feltz, that the urine of the cancerous is more toxic to animals than that of healthy individuals, is, with other facts, highly suggestive of that view.

Kola-Nut for Seasickness.

Dr. C. W. Hamilton of the British Navy writes to the *British Medical Journal* of May 10, 1890, that he has found the seed of the kola (*Sterculia acuminata*) a most successful remedy in seasickness. From half to one dram of the seed was slowly chewed, and in about half an hour the distressing symptoms of the malady gradually disappeared. The writer had never found any drug to act as well as this, and believes that further trials will prove it to be an effectual remedy for seasickness.

ELECTRICAL SCIENCE.

Electric Welding and Ice-Machines.

THE ice-famine is proving a bonanza for the Thomson Electric Welding Company, says the *Boston Advertiser*. There is a great demand at present for pipe-welding machines, with which to make the long coils of pipe for artificial-ice machines, for brewery coils, for sugar-refinery and general refrigerating purposes. The pipes originally come in lengths of from eighteen to twenty feet. The coils are frequently six hundred to seven hundred feet long. By old systems the pipe is welded together by a slow and laborious process, requiring fifteen minutes for each weld, two blacksmiths and a dozen helpers, and a large space, each pipe being lifted from the forge to the anvil, and a mandril inserted. There is often a serious loss of ammonia as a consequence of imperfect welding. By the electric process the welds can be made so homogeneous that there is no chance for ammonia to escape. The length of time required is two minutes for each weld, and all the help required is a man and a boy. The cost of the old process is fifteen cents each; by the new, two cents. As the coil is bent after each weld, the work can be done in a very small space. The managers of the Welding Company consider this, next to shell-welding, the most important industry which has sprung up as a result of the welding invention.

Atmospheric Electricity in the Tropics.

In order to investigate the relations of atmospheric electricity to the moisture of the air within certain limits, Herr F. Exner has made observations of the fall of atmospheric potential in countries with high relative moisture, particularly in the Indian Ocean between Aden and Bombay, in Bombay itself, and in Ceylon, both on the coast and in the interior. According to *The Electrical Engineer* of July 9, the measurements were made with transportable apparatus invented by Herr Exner. All the values of the fall of potential were positive. Near the coast the finely divided spray arising from the breaking of the waves exerted an increased action on the fall of potential. On the other hand, measurements made in Cairo and the vicinity showed that there the dust of the air exerted a lessening influence on the fall of potential, which, with a strong wind, was so marked that the sign of the fall of potential became negative.

Storms and Electric Wires.

It has for some years been the practice at the Berlin post-office, says the London *Electrical Review*, for the employees to make a note of storms and magnetic disturbances, direction of storms, length, etc.; and the result has demonstrated that underground wires, without being entirely free from the influence of magnetic storms, are much less liable to disturbance than overhead ones, and, on the other hand, that accidents from lightning are much less serious in those towns where the overhead system is in vogue.

LETTERS TO THE EDITOR.

*** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

The editor will be glad to publish any queries consonant with the character of the journal.

On request, twenty copies of the number containing his communication will be furnished free to any correspondent.

A Stony Meteorite from Washington County, Kan.

HAVING seen press despatches from Washington, the county seat of Washington County, Kan., announcing the fall of an aerolite near that town on Wednesday, June 25, I visited that county at the earliest possible opportunity, for the purpose of ascertaining the facts. I found them to be as follows, and verified by a multitude of witnesses: At about ten minutes before one o'clock on the afternoon of June 25, the sky being free from clouds, a strange noise was heard by thousands of people residing in the counties of Washington, Republic, Cloud, Clay, Riley, Pottawatomie, and Marshall, in Kansas, and in the counties of Thayer, Jefferson, and Gage, in Nebraska. The same noise was heard by hundreds of people in counties more distant than those mentioned.

The descriptions given me of the character of this strange sound were exceedingly various. Mr. E. F. Woodruff of Clifton, fully twenty-five miles from the place where the meteor struck the ground, stated to me, that while standing on the front porch of his hotel after dinner, a few minutes before one o'clock, his attention was attracted by a rumbling sound like thunder, which began gently, and increased in power to a maximum, rising even above the din of a Missouri Pacific Railroad train which passed within a few rods during the continuance of the phenomenon. The sound appeared to him to come from the zenith, and to continue for two or three minutes, gradually fading away, and being at no time of an explosive character.

Mr. John Yates of Grant Township, more than fifty miles from Washington, on the contrary, heard the sound of the flying me-

teor, and described it as like the report of a hundred-pound cannon, which shook his house, and jarred the windows. He at first supposed the disturbance to be produced by the explosion of a boiler at Gann's elevator, in the neighboring town of Riley. Mr. Sprengle, father of L. J. Sprengle of the *Washington Republican*, not only heard the meteor, but looking toward the zenith, shading his eyes from the glare of the sun, saw just below that luminary a swiftly moving mass of waving mist, followed by a double trail of bluish smoke.

This aerolite was seen by many observers at a much greater distance from the place where it fell. Mr. D. C. Ruth of Halstead, Harvey County, Kan. (a hundred and thirty miles distant in a direction slightly west of south), saw a large fire-ball moving through the atmosphere at a few minutes before one o'clock on June 25. It was also seen at Topeka (eighty-seven miles south-east) by a neighbor of H. R. Hilton, Esq. It was reported by the newspapers as having been both heard and seen at Atchison (a hundred and two miles distant) and at Leavenworth (a hundred and fifteen miles distant), the last two places being in a direction east-south-east from Washington. A note received from C. W. Marston, Esq., of Cedar Junction (a hundred and thirty miles south-east from Washington) makes the following statements: "An aerolite passed in sight of this place on Wednesday, June 25, at about 1 P.M. Of the several who saw it, Mrs. John D. Randall says of it, 'It was a ball of fire as large as a table. It had a trail like a comet, and it wabbled like a kite.'"

At Beatrice, in Nebraska, forty miles north-east of Washington, it was reported as a brilliant meteor passing over the city from north to south, leaving a distinct fiery trail behind. The fact that at places to the north of the point of collision with the earth the meteor appeared to be moving toward the south, while at places to the south it appeared to be moving toward the north, corroborates the testimony given by the nearly perpendicular sides of the hole it made in the ground, that it passed through the atmosphere from the vicinity of the zenith.

The meteor reached the ground, and buried itself out of sight, four feet deep, below the eighteen inches of upper alluvium in the underlying shaly clay or "gumbo." This spot is located three miles and a half north of Washington, in Farmington Township, about a hundred yards from the north and south road, near the south-west corner of the north-west quarter of the south-west quarter of Section 13, Township 2, Range 3, east of the sixth principal meridian. The farm belongs to Mrs. Lydia V. Kelsey of Iowa, and was rented by Mr. J. H. January, who was on that day breaking the prairie sod. The noon hour had not quite expired, and Mr. January was underneath his wagon making some repairs, when he heard the sound of the approaching meteor, and came out to ascertain the cause of the disturbance. He had hardly gained the erect position, when the meteor struck the ground only a few rods distant, throwing up the earth to a height of forty feet into the air, and outwards for about twenty-five feet. It was also seen to strike the earth by Miss Guild, a teacher, who was returning to her home in the country after her forenoon's attendance at the Washington County Normal Institute, and was at the instant driving her horse and cart along the north and south road, only a hundred yards distant. As soon as her frightened and trembling horse had recovered from the shock, Miss Guild drove to the spot, which she reached at the same moment with Mr. January. As soon as Mr. January had calmed his frightened horses, he began to dig for the aerolite; and with the help of a neighbor, Mr. J. D. Foster, and three other men, he reached the upper surface of the stone in one hour, but it required three hours to remove the mass from its bed, it was so firmly held in place by the compressed "gumbo." The stone was not hot when reached, which may be explained by the fact that it seems to have passed through the minimum amount of air from a direction but a few degrees south of the zenith. It was covered, however, by the usual burned crust. The stone was found to have been cracked, doubtless by the force of collision acting upon a body already under the disrupting strain of unequal temperatures. The entire mass weighed a hundred and eighty-eight pounds, and was divided by this crack into two portions, weighing respectively a hundred and forty-four and forty-four pounds. The smaller mass was soon subjected to a process of sledge-hammering by the hundreds of people who almost immediately visited the spot. Nearly every citizen of Washington has in his pocket a small fragment of the stone. The portion remaining, weighing a hundred and forty-four pounds, is somewhat wedge-shaped, in dimensions nineteen by seventeen inches, by eight inches at the base. The writer obtained from Mr. J. D. Foster for analysis a fragment weighing two pounds and a quarter. In color the stone is dark slate, resembling a compact trap-rock. An analysis has been made by Mr. E. E. Slosson, assistant in our chemical department, whose preliminary report is as follows:—

"The stone is of a gray color, and in texture resembles porphyry. A few metallic grains are all that can be distinguished with the naked eye. Under a microscope by chemical treatment the following minerals can be detected:

"1. A white crystalline silicate, insoluble, forming about half the mass of the whole; probably enstatite or a similar bisilicate of the pyroxene group.

"2. A black translucent crystalline silicate intermingled with the above, though less in amount. It is decomposed by *aqua regia*, and contains iron; probably a uni-silicate of the olivine type. These two minerals are in some fragments arranged in alternate microscopic layers of equal thickness.

"3. Malleable nickeliferous iron in small irregular masses, intimately mixed with troilite and the silicates.

"4. Troilite or pyrrhotite in microscopic particles disseminated through the whole rock, estimated from sulphur to be about 10 per cent.

"5. Chromite, distinguishable as small black magnetic crystals in the residue after treatment with the acids.

"6. A few scattered silicious crystals, yellow and red; too small to determine, probably olivine.

"The following is an approximate analysis of a small fragment: metallic iron (with part of the iron in silicates), 14.953 per cent; troilite, 10; soluble silicates (olivine), 25.147; insoluble silicates (enstatite), 49.9; nickel and chromite, undetermined; specific gravity of fragment weighing two pounds and a half, 3.48, water at 25° C."

The hundred and forty-four pound mass has been bought by the writer and Professor F. W. Cragin of Washburn College, Topeka, in equal partnership, for the benefit of the museums of their respective institutions.

F. H. SNOW.

University of Kansas, Lawrence, Kan., July 7.

Another Meteorite from Kiowa County, Kan.

SINCE my communication in *Science* of May 9, in reference to the Kiowa County (Kansas) meteorites, I have again visited the locality, and obtained a 218¼-pound pallasite. This is not a new "find," but is one which was first discovered upon the farm of Mr. James Evans more than a year ago. The location may be seen by consulting the map illustrating Mr. Kunz's article in *Science* of June 13. Only about one square foot of the surface of this meteorite, just level with the ground, was exposed to view, and it thus easily escaped subsequent observation on the unploughed, grassy prairie. The dimensions are 20½ by 16½ inches, by 10½ inches at base. The shape is that of an irregular triangular pyramid, and it stands easily upon its base. The specimen, not having been exposed to the weather and the dangers of rough usage, as were the other members of this group, presents fine clusters of olivine crystals in several cavities upon two of its faces. There are eight cavities on one face. Some of the cavities are four inches in diameter and two inches deep. Nearly all the cavities contain fine crystals of yellow olivine and of chromite. Some of the former are $\frac{3}{16}$ of an inch in diameter, and so perfect that the angles can readily be measured. This specimen is also unique in that the crystals of chromite are so large and so prominent. The chromite has a fine lustre, gives a dark-brown powder, and scratches glass.

Much of the olivine is black and glassy, with a conchoidal fracture. It shades imperceptibly into the honey-yellow and colorless varieties. The light variety yields a light-brown powder, and is very brittle. Its fusibility is about five.

At some points on the surface there is a dirty white incrustation. This, on examination, proved to be carbonate of lime, and is without doubt due to the deposits from the calcareous soil in which the meteorite was embedded.

The prevailing color of this iron is dark reddish brown, more inclined to red than others of this fall that we have seen.

On cutting a section from the meteorite, and treating the polished surface with nitric acid, the characteristic Wiedmannstaaten markings are visible. The fragments of troilite can be plainly seen on the polished surface. The meteorite has about the same arrangement of iron, olivine, etc., as others of this group. Its specific gravity, as obtained from the whole mass, is 4.79; that of the iron and nickel alloy is 7.70; of the olivine (yellow), 3.64 (water at 25° C). The volume of the entire mass, determined in the process of obtaining its specific gravity, was found to be 20.6 litres.

Professor E. H. S. Bailey of this university is making a thorough analysis of this pallasite, which he will report in detail at the Indianapolis meeting of the American Association for the Advancement of Science. F. H. SNOW.

University of Kansas, Lawrence, Kan., July 9.

A Supposed Footprint in Rock.

IN a field belonging to Mr. J. G. Bemis, in the town of Whitefield, Coos County, N.H., there is a rock of granite upon which is the impression of a man's left foot. It is a naked foot, and has slipped slightly in passing over the rock when in a muddy condition. No one had mentioned this fact to Mr. Bemis when he bought the farm. The rock is like the rest of the rocks in the place, granite. The place is a very solitary one; and probably no one, till Mr. Bemis came, who is a man of much observation, ever observed it.

A sketch made by Professor Grundmann, and specimens of the rock, were shown to Mr. Walter G. Davis, the director of the Meteorological Bureau, Cordoba, South America. He considered it very curious, but, not being a geologist by profession, advised its being brought to notice. The place is two miles north of the village of Whitefield, N.H., not far from The Mountain View House, owned by Mr. W. F. Dodge, and near the estate of the Rev. R. C. Waterston (summer residence). A. W.

BOOK-REVIEWS.

School Supervision. By J. L. PICKARD. (International Education Series.) New York, Appleton. 12°. $1.

THE author of this book has had a long experience as superintendent of education, first in the public schools, and now at the head of a university. He evidently has a natural aptitude for the work; and this, combined with long practice, has enabled him to produce a work on the duties and usefulness of school superintendents which will be very suggestive to those who fill such positions, as well as to educators generally. He maintains in strong terms the importance of good supervision by State, county, and city authorities, and has no difficulty in showing that it has largely promoted the efficiency of the public schools of this country. He devotes comparatively little space to the State and county superintendents, but discusses at length the work of the city superintendent, pointing out its relation to the teachers, the pupils, and the public authorities, with incidental suggestions on every important point. President Pickard fears that the grading and the minute rules for teaching and for the promotion of pupils are making our schools too mechanical, and earnestly advocates leaving greater freedom to both teacher and pupil. The methods of examination, too, he thinks require amendment, so that the examination shall test the pupil's judgment rather than his memory. He favors moral and religious instruction in the public schools, notwithstanding the difficulties arising from the conflicting views of the various religious sects. His mode of presenting his thought is somewhat marred by a too free use of metaphorical

illustration, and his subject is one that cannot be made exactly entertaining; but all who are interested in the practical working of our public-school system will like to read his book.

AMONG THE PUBLISHERS.

THE Alvarenga prize of the College of Physicians of Philadelphia, consisting of one year's income of the bequest of the late Señor Alvarenga of Lisbon, has been awarded to Dr. R. W. Philip of the Victoria Dispensary for Consumption and Diseases of the Chest, Edinburgh, for his essay on pulmonary tuberculosis, which will be published by the college.

— Harper & Brothers have just ready "The Aztec Treasure House," by Thomas Janvier, who, in the form of romance, gives the result of many years of unremitting labor, and furnishes reliable facts regarding Yucatan and Mexico, put together with his special knack at artistic color in word-painting.

—In consequence of his having been appointed sole agent in America for the Religious Tract Society's publications, Fleming H. Revell announces the following periodicals published by the society: *The Leisure Hour*, *The Sunday at Home*, *The Boy's Own Paper*, *The Girl's Own Paper*.

—"A Story of Damon and Pythias," by A. Cressy Morrison, has been issued by the Pabst Brewing Company, Milwaukee, Wis. This little book will interest many of our readers, especially as it is illustrated with a half-dozen views, admirably reproduced, of scenes on the Island of Sicily. Doubtless copies can be had on application to the publishers.

—D. C. Heath & Co., Boston, will add to their series of German texts in a few days, "Selections from Heine's Poems," edited, with an introduction and notes, by Horatio S. White, professor of the German language and literature in Cornell University. This volume will embrace selections not only from the more familiar "Buch der Lieder," but also from Heine's later and posthumous poems, an examination of which is essential to complete the picture of his matured genius.

—We learn from *Nature* of July 3 that Messrs. Mawson, Swan, & Morgan propose to issue a lithographed facsimile of an old manuscript volume of apothecaries' lore and household recipes, which was discovered some years ago among the papers belonging to the old firm of Gilpin & Co., chemists, Pilgrim Street, Newcastle. Careful examination, in which some of the curators of the British Museum have assisted, shows that the manuscript dates from about the time of Queen Elizabeth, additions having been made from time to time, in various handwritings, up to the middle of last century.

—Messrs. Macmillan & Co. have nearly ready for publication two works of great interest to students of ornithology, both of American origin. The first is a treatise on the "Myology of the Raven," intended as an introduction to the study of the muscular system in birds, by Dr. R. W. Shufeldt of the Smithsonian Institution. The second is a revised re-issue, in one volume of convenient size, of the very valuable monographs on field ornithology and on general ornithology, which were prefixed to Dr. Elliott Coues's monumental "Key to North American Birds." Part I., on field ornithology, contains the necessary instructions for the observation and collection of birds in the field, and for the preparation and preservation of specimens for scientific study. Part II. is a technical treatise on the classification, the zoölogical characters, and the anatomical structure of the class of birds, in which the examples cited in illustration of the principles of ornithology have for the most part been re-drawn by the author from British instead of American birds.

Wants.

Any person seeking a position for which he is qualified by his scientific attainments, or any person seeking some one to fill a position of this character, be it that of a teacher of science, chemist, draughtsman, or what not, may have the 'Want' inserted under this head FREE OF COST, *if he satisfies the publisher of the suitable character of his application. Any person seeking information on any scientific question, the address of any scientific man, or who can in any way use this column for a purpose consonant with the nature of the paper, is cordially invited to do so.*

A ZOOLOGIST, acquainted with the United States, graduate (Ph.D. Freiburg, B.Sc. of an English university) of many years' standing; late Fellow of an English college; late assistant to a German university, professor of Comp. Anatomy; many years a student at two German universities; pupil of Huxley, Kölliker, Semper, Wiedersheim and Weismann; author of many well-known memoirs on Comp. Anatomy and Embryology; thoroughly conversant with all branches of the subject; fond of teaching, with good testimonials, seeks a Professorship. Address "MORPHOLOGIST," Office of SCIENCE. Other information and a few testimonials can be seen at the Office of SCIENCE.

AN EXPERIENCED TEACHER desires to hear of a town in which he can establish a high school. Or, he will lease an academy. Address, G., Lock Box 19, Suffern, N. Y.

WANTED.—By a lady-graduate of Cornell University, position as teacher in high school, seminary or college; prepared to teach the following branches, employing, so far as is practicable, the laboratory method: Geology, Botany, Zoölogy, Physiology; also, if desired, Physics, Chemistry, Logic and Psychology. References to heads of above-named departments in Cornell University. JENNIE T. MARTIN, care Cornell University, Ithaca, N. Y.

A GENTLEMAN of experience, highly recommended, liberally educated at home and abroad, desires to correspond with parties needing an instructor in the classics or modern languages in a high-grade institution. Address EARLHAM, Germantown, Pa.

WANTED.—At the Bryant Summer School, Roslyn, L. I., a Lady to teach Sea-Life, and other Sciences. July 8-Sep. 8. Ten weeks to six months according to her convenience. Other papers please copy. E. HINDS, A.M., Principal.

WANTED—Information concerning the production of Mushrooms in caves and other places. Address M. H. CRUMP, care Ky. Geological Survey, Frankfort, Ky.

A YOUNG MAN, graduate from an American College, who has studied a year in Germany, and is now studying in Paris, would like professorship in chemistry. References from some of the best chemists. Address CHARLES E. LINEBARGER, Post-Restante, Paris, France.

WANTED.—An opportunity to study qualitative analysis in or near New York City during the summer. W. J. L., 130 Spring st., Sing Sing, N.Y.

ASSAYER.—Wanted position as above, has had three years' practical experience in a London firm of assayers to the Bank of England, Royal Mint, etc., etc. Thorough knowledge of bullion assaying, and of gold, silver and lead ores. I. FRED. JOHNSON, Northgate Brewery, Canterbury England.

Exchanges.

[Free of charge to all, if of satisfactory character. Address N. D. C. Hodges, 47 Lafayette Place, New York.]

For exchange—14 volumes (1883-1889) American Journal of Science, 10 volumes (1880-1889) American Naturalist, 21 volumes (1879-1890) English Mechanic, all in good condition for binding; also, Morris Typewriter. Wants first-class microscope, camera, chemical or physical apparatus. Address, with full particulars, E. R. Chadbourn, Lewiston, Maine.

Wanted.—To exchange land and fresh-water mollusca, (principally *Helices Achatinellae*, Clausiliae and Limnaeae,) for those not in my collection. Lists exchanged. Address E. H. White, Box 200, Astoria, Or.

Meteorites.—Mr. George F. Kunz, 11 to 15 Union Square, New York, or Hoboken, N. J., will buy or give in exchange for whole or parts of meteorites. Whole ones, undescribed ones, and entire falls especially desired.

Wanted—To furnish roots of *Dodecatheon Meadia*, *Sarracenia purpurea*, and other wild flowers, native of Southern Wisconsin, in quantities. D. E. Willard, Curator of Museum, Albion Academy, Albion, Wis.

I have a number of duplicates of microscopic slides, mostly botanical, which I would like to exchange for others not now in my collection. Send list of what you have to exchange and get my list. S. R. Thompson, New Wilmington, Pa.